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Mesosphaerum suaveolens (L.) Kuntz.: A serious threat to Uttarakhand's first Ramsar site, India

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ABSTRACT

Biological invasions have significant ecological and environmental impacts on different ecosystems across the world. Wetlands well known as diverse and productive ecosystems provide critical habitat for a wide range of plant and animal species. However, these ecosystems are also grappling with the disruptive impacts of invasive plant species. The current communication aimed to assess the rapid invasion of *Mesosphaerum suaveolens* (L.) Kuntz. in the Asan Conservation Reserve (ACR), the first Ramsar site of Uttarakhand, India. Based on field investigations, the study revealed that *M. suaveolens* is rapidly spreading due to its high reproductive capacity and adaptability to thrive in a wide range of habitats in ACR. The species is encroaching on natural habitats of the wetland and poses a serious threat to survival of the native plant species. The findings of this study highlight the urgent need to control and monitor the invasion of *M. suaveolens* and develop area specific ecological restoration measures.

Keywords: Conservation, Ecosystem, Invasion, Threat, Wetland

1. INTRODUCTION

Invasive species has the potential to harm the environment, economy and human health by rapidly spreading and outcompeting native species (Cambray, 2003; Chandra et al., 2023; Khadka et al., 2021; Dhakal et al., 2021). These species possess unique characteristics, such as quick reproduction, fast growth, high seed dispersal, adaptability to changing environmental conditions, lengthy seed viability and high germination percentage, that results to dominate over other species (Cochrane et al., 2015; Masroor et al., 2022). The invasive plant species spread quickly within local plant communities (Richardson et al., 2000) and pose a significant challenge to natural ecosystems (Mack et al., 2000).

Wetlands well known as diverse and productive ecosystems provide critical habitat for a wide range of plant and animal species. However, these ecosystems are also grappling with the disruptive impacts of invasive plant species. The introduction of non-native species to wetlands poses a significant threat, particularly invasive species that can cause harm to the ecosystem and native

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species that depend on wetlands for survival (Sagoff, 2005). The invasive alien plant species can rapidly alter the local community's structure and function, leading to degradation of the wetlands habitat (D'antonio and Meyerson, 2002).

Keeping the aforementioned in view, the current study was conducted to assess the invasion of plant species in the Asan Conservation Reserve (ACR), the first Ramsar site of Uttarakhand, India. The wetland is facing tremendous threats due to the proliferation of invasive species such as *Mesosphaerum suaveolens* (L.) Kuntz., *Ipomoea carnea* Jacq., *Pontederia crassipes* Mart., *Typha angustifolia* L., *Lantana camara* L., *Parthenium hysterophorus* L., *Ageratina adenophora* (Spreng.) R.M.King & H.Rob., *Bidens pilosa* L., *Cassia tora* L. and *Antigonon leptopus* Hook. & Arn.

Owing to profuse growth over the years in aquatic and adjoining terrestrial habitats, these invasive species have led to a change in the vegetation structure and composition of the Asan wetland and its adjoining areas. *Mesosphaerum suaveolens*, in particular, has significantly increased its encroachment in the last four years when compared to other invasive plant species, which is noteworthy and the reason behind current study. The major objectives of this study include investigation on the population status and invasion pattern of *M. suaveolens* in ACR and suggest area specific ecological restoration measures.

Study area

The Asan Conservation Reserve, located on the banks of the Yamuna River in the Indian state of Uttarakhand, is a man-made wetland covering approximately 4 km^2 (Figure 1). Owing to its significance as an important habitat for a wide range of aquatic and migratory bird species, ACR was designated as a Ramsar site in 2020. The vegetation of the ACR is predominantly composed of aquatic plants species such as *Typha angustifolia* L., *Phragmites karka* (Retz.) Trin. ex Steud., *Nymphaea nouchali* Burm.f. and *Hydrilla verticillata* (L.f.) Royle, *Ipomoea carnea* Jacq. and *Pontederia crassipes* Mart., to name a few, which provide food, shelter and nesting sites for a variety of bird species.

The adjoining areas of the wetland supports a number of terrestrial plant species such as *Senegalia catechu* (L.f.) P.J.H.Hurter & Mabb., *Dalbergia sissoo* Roxb. ex DC. and *Bombax ceiba* L. and *Mallotus nudiflorus* (L.) Kulju & Welzen, to name a few. The diverse habitats of the ACR are favorable for a large number of migratory birds as it provides ideal feeding and nesting habitats for waterfowl, shorebirds and other aquatic birds. The designation of the ACR as a Ramsar site highlights the importance of this wetland as a critical habitat for a wide range of bird species and an important provider of ecosystem services.

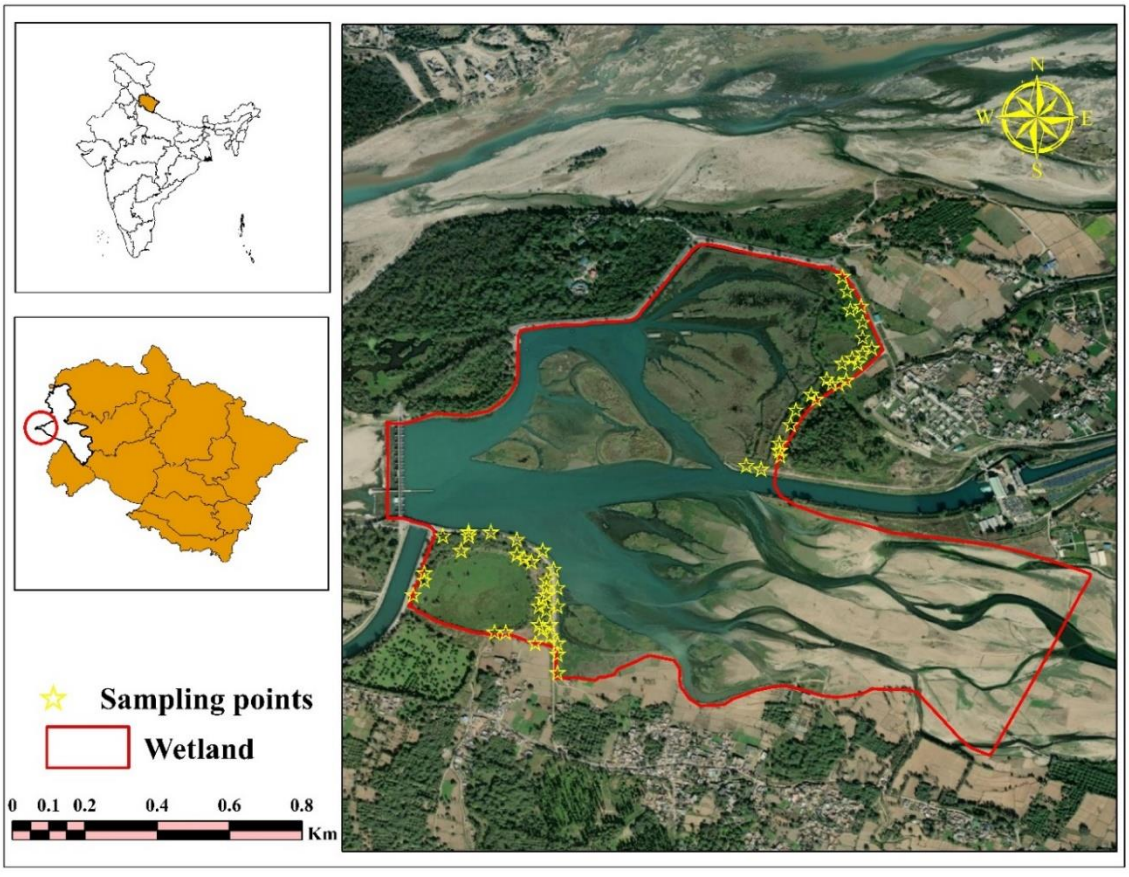

Figure 1 Map showing location of the Asan Conservation Reserve, Uttarakhand, India along with sampling points

2. METHODOLOGY

Survey was conducted during 2021-2022 to elucidate proliferation of *Mesosphaerum suaveolens* in ACR. Based on the major habitat types, abundance of species was evaluated in three sites viz., *Lantana-Mesosphaerum* dominated, *Mesosphaerum- Pontederia* dominated and *Mesosphaerum* dominated sites. The phyto-sociological data were collected and analyzed for density, frequency, abundance and other relevant parameters following Ellenberg and Muller-Dombois, (1974). The distribution pattern viz., regular (0.050) random (0.025 to 0.050) and contagious (>0.050) of species was determined by using A/F value (Whitford, 1949).

3. RESULTS AND OBSERVATIONS

Based on a total of 46 plots (1×1m) studied across three habitats, the present study revealed that *M. suaveolens* has spreaded in 34% (0.85 km^2) of the total area of ACR (4 km^2). Notably, it has formed a huge patch of >50x50m at south west site of the reserve. The density of *M. suaveolens* ranged between 11-14.5 individuals/m^2 in the selected sites of ACR. Of the average population recorded (1,10,000/hectare) across the selected sites, about 46% individuals were recorded in gregarious patches dominated by *Mesosphaerum* (Figure 2), followed by *Mesosphaerum-Lantana* (34%) and *Mesosphaerum-Pontederia* (20%) dominated sites. The presence of *M. suaveolens* was primarily recorded between 15° to 20° slopes in rocky and sandy soils.

Figure 2 Gregarious growth of *Mesosphaerum suaveolens* observed in Asan Conservation Reserve, Uttarakhand, India

Overall, the species showed contagious distribution (A/F=0.14) across the selected sites. The dominant species growing along with *M. suaveolens* in the selected sites were *Bergera koenigii* L., *Sida cordifolia* L., *Cassia tora* L., *Senna occidentalis* (L.) Link, *Calotropis procera* (Aiton) W.T.Aiton, *Sesamum indicum* L., *Parthenium hysterophorus* L., *Bidens pilosa* L. and *Pogostemon benghalensis* (Burm.f.) Kuntze. Considering the current dispersal pattern, abundance and spread, it was observed that *M. suaveolens* is proliferating rapidly in and around the wetland. A total of 53 plant species from samples sites was recorded, of which 13 species occurred in the *M. suaveolens* dominated locations.

The preliminary analysis of diversity index significantly decreased with increasing *M. suaveolens* dominance, suggesting that the species diversity decreased with increasing *M. suaveolens* dominance along the sampled sites. At heavily invaded sites of *M. suaveolens*, it was observed that a total ~60-70 individuals were encountered within 1×1m plots indicating its rapid proliferation.

Subsequently, *Pontederia crassipes* is abundant to a certain extent in wetland's north-western portion, although the forest department is instrumental in its periodic removal. Despite negative effects of *Pontederia crassipes* on freshwater ecosystems, it cohabits *M. suvaveolens* at peripheral locations in ACR.

4. DISCUSSION

Over the past 1,000 years, humans have intentionally and unintentionally spread plants far beyond their original ranges through transportation and commerce (Mack et al., 2000). The success in invasion of any alien plant species depends on a number of variables, including the availability of resources, reproduction biology and the recipient habitat's invisibility, which aids in the spread and establishment of such species (Daneshgar and Jose, 2009). For the rapid spread of *M. suaveolens* in open areas, Raizada, (2006) identified a number of characteristics, including superior reproduction, dispersal advantages, possible allelopathic chemicals and the capacity to withstand adverse conditions.

As compared to uninvaded areas, it was observed that *M. suaveolens* prefers habitats with rocky and sandy soil. It is submitted that the operation is only successful if invasive species such as *M. suaveolens* are eradicated at an early stage of growth. The removal of an established invasive species may allow a different non-native species that had been controlled to invade the area. As a result, appropriate management techniques such as manual removal on a regular basis to prevent future harm to the ecosystem are required to curb the spread of *M. suaveolens*.

5. CONCLUSION

The invasive potential of *M. suaveolens* in ACR poses a significant threat to the management of the wetland ecosystem. Additionally, like *M. suaveolens*, several other invasive alien species such as *Ageratina adenophora*, *Lantana camara*, *Mesosphaerum suaveolens*, *Cassia tora* and *Parthenium hysterophorus* are causing serious problems to the surrounding vegetation of ACR. This, in order to stop further invasion by *M. suaveolens* and other invasive species, the invaded locations must be regularly monitored. Conclusively, preventive measures, such as early detection, periodic removal and monitoring can help to prevent further spread of invasive species to the reserve.

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Authors' Contribution

APM and NC: Manuscript writing and data interpretation; AK: Supervision and editorial inputs; GS and SS: Manuscript editing and technical inputs.

Informed consent

Not applicable.

Ethical approval

The ethical guidelines for plants & plant materials are followed in the study for sample collection & identification.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Data and materials availability

All data associated with this study are present in the paper.

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